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Eco-Cities: Possible or Purely Utopian?

by

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14. ABSTRACT This paper proposes that the successful development of a grand eco-city depends on a state's political and economic resources, its motivations and objectives for building an eco-city, and the overall sustainability of the city's design. Comparing China's failed Dongtan plan with the UAE's still hopeful Masdar initiative will identify similarities and differences in China's and the UAE's resources and approaches in order to evaluate Abu Dhabi's prospects for success in this ambitious endeavor.					
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Escalating environmental and energy security concerns are colliding with the global realities of rapid development, population growth, and urbanization. The resulting pollution, climate change, and depletion of fossil fuels will increasingly devastate the world's economy and health. Some individuals and nations choose to bury their heads in the sand and ignore these impending dangers, while others attempt to mitigate the negative effects by tackling various aspects of the problem in isolation. There are a few, however, that are racing towards a grand comprehensive solution: the eco-city. Ambitious plans for large-scale eco-cities have existed for decades, yet none has been successful to date. Two recent and notable eco-city plans are China's Dongtan City and the United Arab Emirates' (UAE) Masdar City. The Dongtan proposal was unveiled in 2005, yet still only exists on paper, and will likely remain that way. Is Abu Dhabi's Masdar City, announced in 2006, doomed to the same disappointing fate? This paper proposes that the successful development of a grand eco-city depends on a state's motivations and objectives for building it, the political and economic resources available, and the overall sustainability of the city's design. Comparing the failed Dongtan plan with the still hopeful Masdar initiative will identify similarities and differences in the Chinese and Emirate projects in order to evaluate Abu Dhabi's prospects for success in this ambitious endeavor.

While there is no universal definition of an eco-city, Richard Register, one of the founders of urban ecology, defines it as "a human settlement that enables its residents to live a good quality of life while using minimal natural resources."¹ Eco-cities are designed to limit environmental impact by relying on renewable energy sources and producing the lowest possible amount of pollution. The term has been used to describe a broad array of initiatives including retrofitted industrial areas and small eco-villages, but this paper limits its application to brand

new carbon neutral cities like Dongtan and Masdar that are meant to be completely environmentally sustainable.

The UN World Commission on the Environment and Development first coined the term “sustainable development” in 1987, defining it as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”² Today, there are numerous definitions of “sustainability” and while the term is often used in an environmental context referring to living within the regenerative capacity of the planet, most definitions recognize there is a requisite balance between environmental, social and economic concerns.³ If one of these factors is elevated and focused on to the detriment of the others, it can jeopardize a community’s sustainability. For example, developing nations often concentrate on expanding economic opportunities, which can lead to improved social conditions for their populations yet ignores corresponding environmental damage. Conversely, if environmental protection is prioritized above all else, economic opportunities may be so severely restricted that inhabitants are unable to maintain an acceptable quality of life. While both of these situations can and do occur, neither is sustainable in the long term. Developing nations must eventually deal with the health problems and environmental contamination their actions produce, while the environmentally pristine community may dissolve if its inhabitants are forced to relocate in order to survive. Therefore, while the task of powering an eco-city with renewable energy and maintaining a zero-carbon footprint is challenging enough, planners must consider other factors for a truly sustainable eco-city to become a reality and not just a utopian ideal.

Objectives

China’s plan for the world’s first eco-city is Dongtan, located near Shanghai and next to sensitive wetlands on Chongming Island at the mouth of the Yangtze River. China has touted

Dongtan as the first of 20 sustainable eco-cities it plans to build over the next 20 years to house its growing population. The Shanghai Industrial Investment Corporation (SIIC) contracted with Arup, a British engineering firm, to design and build the city with zero greenhouse gas (GHG) emissions, low energy consumption, and to be completely self-sufficient for both water and energy. Dongtan itself would consist of three village neighborhoods. All housing would be within a seven-minute walk (approximately 500m) to public transport, and residents would have easy access to social infrastructure such as hospitals, schools, and work. Buildings would have numerous innovations to reduce energy demands, including green roofs made of turf and vegetation to serve as insulation and to recycle wastewater. Photovoltaic panels and small windmills incorporated into building designs would provide up to 20% of required energy. Up to 80% of the city's waste would be recycled in composts or used for energy generation, such as burning widely available rice husks as a biofuel. Overall, Dongtan was designed to incorporate numerous existing technologies (not pioneer new ones) in order to use 64% less energy than comparably sized, business-as-usual cities.⁴ The first phase of the city, a marina village housing 20,000 inhabitants, was supposed to be open in time for the 2010 World Expo in Shanghai. The project was then to grow into a city three quarters the size of Manhattan (86 km²) with half a million residents by 2050. Unfortunately, while a bridge and tunnel connecting Chongming Island to Shanghai recently opened, not a single eco-building has been erected, and prospects for getting the project back on track are not promising.

The UAE launched its own ambitious plan to build the world's first eco-city in 2006. Masdar is a bit more modest than Dongtan, but only in terms of physical size. Intended to be a carbon-neutral, zero-waste city powered entirely by renewable energy, the \$22 billion project includes an education and research institute, as well as investment and special project units.⁵ In

addition to providing homes for 40,000 residents and jobs for another 50,000 daily commuters, Masdar will also serve as a real world laboratory to test clean technology solutions. Abu Dhabi has contracted with Fosters & Partners, a British architectural firm, to plan and design the 6 km² oasis located in the middle of Abu Dhabi's desert. In a pleasant twist, the architects are drawing upon traditional Middle Eastern designs, such as those found in Sana'a and Damascus, for both aesthetics and for lessons on what works in the harsh desert environment. For example, a wall will surround the city in order to block strong desert winds while also preventing sprawl and housing the city's water filtration system. Narrow, winding streets will lead to a central, open-air souk, wind towers will cool homes, and screens based on traditional *mashrabiya*s (ornate carved or latticed screens through which breezes can flow while blocking the hot sun) will shade courtyards and shops.⁶ There will be no cars in Masdar. Rather, almost 2,000 computerized, battery-powered Personal Rapid Transit (PRT) pods—always within a 200m walking distance—will be available on-demand.⁷ New rail and public transport routes, as well as a network of existing roads, will link Masdar to surrounding communities, including Abu Dhabi and the international airport. The city will generate all of its own power with solar and wind technologies, and will recycle all waste and water. Construction began in 2008 with a projected completion date of 2016.

Motivations

The sheer complexity and scope of trying to build the world's first eco-city begs the question of why China and the UAE would undertake these massive projects. Both countries have very pragmatic reasons, including rising domestic energy requirements and environmental concerns. China is currently the world's second largest energy consumer after the United States, and its consumption levels are rising dramatically due to several factors. Although it only has a

0.6% growth rate, with China's current population of 1.3 billion that translates into an increase of 300 million people (the current population of the United States) in the next 30 years. Many of those people are moving to China's cities where they consume more energy per capita than in rural areas, and which are expanding at a phenomenal rate of 10% a year. This rapid urbanization is putting great strains on the region's environment, to include significant air and water pollution, and has contributed to China being the world's largest source of GHG emissions.⁸ Perhaps more significant than its expanding population is how many Chinese are entering the middle class. China's economic development, as measured in GDP growth, has hovered around 10% a year for the last decade, only dipping to 7% during the Asian financial crisis in the late 1990s.⁹ The International Energy Outlook for 2009 projects China will continue to have one of the highest economic growth rates in the world through 2030, and identifies this as one of the most important factors when projecting energy consumption.¹⁰ To underscore this point, China's per capita energy consumption increased 41% from 2003 to 2007. During this same period, the world's average per capita energy consumption increased by only 8%.¹¹ China's rapidly growing energy needs and environmental concerns have led it to invest significantly in foreign energy sources, in addition to focusing more on efficiency and alternative energy options. It is within this context that investing in an eco-city like Dongtan makes sense.

The UAE shares many of China's problems and concerns, but on a relatively smaller scale. Only 4.7 million people live in the UAE, a country about the size of Maine, but almost 80% of them live in urban areas. With the highest population growth rate in the world, estimated at 3.69% for 2009, urban development will continue to expand dramatically.¹² Excellent GDP growth (it has the world's seventh highest GDP per capita) and an expanding energy-intensive tourism industry have led to rapidly increasing electricity consumption. In fact, the UAE is the

seventh largest per capita consumer of energy in the world, and officials are projecting domestic demands for power will more than double by 2020.¹³ Despite having the world's sixth largest proved oil reserves and fifth largest proved natural gas reserves, the UAE is also experiencing domestic energy shortages.¹⁴ With its gas production insufficient to meet needs, the UAE had to begin importing natural gas in 2007 to satisfy domestic electricity production, water desalinization, and enhanced oil recovery systems used in its mature oil fields.¹⁵ On the environmental front, the UAE is the second largest per capita emitter of GHG emissions (China is #96).¹⁶ This has contributed to much skepticism towards the Masdar initiative, with some claiming it is merely whitewash to distract from the country's massive carbon footprint. While certainly not perfect, Abu Dhabi's leadership does appear committed to cleaning up its environment; it was the first major oil-producing country to ratify the Kyoto Protocol in 2005.

Other compelling reasons for the UAE to embark on building this ambitious eco-city is for potential economic diversification. Abu Dhabi recognizes oil supplies are limited and is trying to diversify its fossil-fuel based economy. Masdar is an attempt to expand into knowledge-based industries and position Abu Dhabi as a world-class research and development hub for new energy technologies. Compounding the economic benefits, the aspired transition to technology exporter would likely boost the UAE's regional and international prestige.

Political & Economic Resources

On the surface, both China's and the UAE's political and economic resources appear conducive for building grand eco-cities. Both states have authoritarian governments that can generally do what they want and are willing and able to minimize public opposition to state initiatives if necessary. A democratic government, on the other hand, would likely be so plagued by special interest groups' competing desires that a project of this magnitude might prove

impossible. The UAE has the advantage over China, however. It has a small monarchy with no democratically elected institutions or political parties, few actual citizens (only 20% of the population), and enormous financial resources to head-off or co-opt any opposition that might develop. Additionally, the leader of Abu Dhabi (who also happens to be President of the entire UAE), has taken a personal interest in Masdar and appears to have the political will to see it through. Moreover, Abu Dhabi has cultivated international involvement in the project, resulting in the June 2009 decision to house the International Renewable Energy Agency (IRENA) in Masdar City. This is the first time an international organization has chosen a Middle Eastern city for its headquarters, and will likely motivate leaders and planners to stay on track. Economically, Abu Dhabi has tremendous oil and gas wealth that has enabled it to invest \$15B of the \$22B projected price tag. Strategically, it views this as an investment in the country's economic diversification and is likely expecting sizeable returns over the long run.

In stark contrast, although China definitely has a top-down political culture, it is run by the world's largest political party—the Communist Party of China with over 70 million members. Inter-party conflict and intrigue can easily derail a project even without public opposition, as it appears has happened in this case. The main sponsor of Dongtan was Chen Liangyu, Shanghai's 'mayor' and Communist Party boss, not the central government in Beijing. Chen was arrested in 2006 and recently sentenced to 18 years in prison for property related fraud, including charges of bribery and abuse of power. Because of this corruption scandal, no one in the current Shanghai administration wants to be involved in Dongtan due to its association with Chen.¹⁷ Since China did not cultivate international involvement in the project, there are no external forces pushing the government to stay on track. As a result, SIIC has effectively put construction on hold by allowing the planning permissions, which must be renewed annually, to

lapse.¹⁸ From a financial perspective, while China has experienced impressive economic growth in the last few decades that could help fuel Dongtan's modest development cost of \$1.3B, authorization of project funds was reportedly stalled in July 2007.¹⁹ According to Paul French, a partner in the research publisher Access Asia, there also seems to have been some confusion over who was going to pay for the city. Arup thought they would produce the design for a large fee and the Chinese would build it; SIIC supposedly thought Arup was going to build the project and they would get the city for free.²⁰

Sustainability

In terms of overall sustainability, there are significant contrasts between the two projects. Environmentally, both Dongtan and Masdar face major challenges based on their locations. Masdar is being built in the middle of a desert, which limits concerns about wildlife habitats, but raises questions about the environmental impact of importing all the necessary resources to make it hospitable. Even if the city itself is carbon neutral, the transportation of building materials, commercial products, water, and food should be considered. While the new rail system connecting Masdar to other cities helps reduce this concern, the potential for significant GHG emissions by conventional trucks supplying the carbon neutral city would negate its environmental sustainability. Dongtan's environmental situation is more precarious. Located next to pristine wetlands that are migratory stops and homes for seven endangered and 34 protected wildlife species, there is no room for mistakes. Planners claim preservation of wildlife and agriculture was a primary factor in the design, and they did create a buffer zone between the natural wetlands and the city that is 3.5km wide at its narrowest point. These efforts have not stopped local environmentalists and academics from speaking out against the project, however. Additionally, many Dongtan residents would have to commute to Shanghai for work, which

would simply transfer the carbon saved by the city's design to China's transportation sector.²¹

Questions about Dongtan's environmental sustainability led to Arup receiving the 2007

"Greenwasher of the Year Award" from Ethical Corporation Magazine for the most dubious green claim of the year.²²

Economic sustainability, or the ability of the local economy to support residents, is another important factor when considering if an eco-city is a realistic endeavor. Even if Dongtan's construction were to proceed as planned, little has been done to ensure employment opportunities would exist for its residents. Planners appear to be relying on future policy incentives to attract companies pursuing new technologies, health care, and ecotourism to the city.²³ In the mean time, many residents would likely have to commute to work, making Dongtan nothing more than an "upscale dormitory" for Shanghai.²⁴ Abu Dhabi, on the other hand, is incorporating a world-class research and education institute in the city through partnerships with prestigious organizations like MIT. They have also begun luring international organizations, like IRENA, and renewable energy businesses to relocate there, ensuring significant employment opportunities by the time the city is built. While China seems to be focused on building just another city that happens to be environmentally friendly, the UAE is laying the groundwork to build an economically integrated community.

Social sustainability, or accounting for local perspectives and lifestyles, is an area often overlooked by city planners. Once again, Masdar has the advantage. Planners have made concerted efforts to incorporate architectural elements to preserve local Middle Eastern culture, along with decisions like using family-sized PRT pods, instead of mass transit, to help preserve local norms of privacy. While many early residents will be foreign, Arabs must be comfortable living in Masdar if the UAE is to succeed in developing an indigenous knowledge-based

economy. No information is currently available about projected housing prices in Masdar, but Abu Dhabi will need to be vigilant in establishing a diverse housing program to accommodate a broad socioeconomic spectrum and thus facilitate sustainability.²⁵ Conversely, Dongtan's planners may have focused on environmental sustainability at the expense of social considerations. For example, they convinced China to rotate the city grid slightly off a north-south axis to utilize cool breezes for natural ventilation, violating the traditional Chinese planning practices of feng shui.²⁶ While Westerners might scoff at the significance of this, some Chinese take it very seriously and if Dongtan is ever built, it may be difficult to populate. To illustrate how important feng shui is in Chinese culture, in 2005, Disney modified their building plans for Hong Kong Disneyland by shifting the angle of the front gate by twelve degrees in order to abide by local culture.²⁷ Aside from cultural problems, it is not entirely clear who would live in Dongtan. Plans call for integrating the areas current small population of fishing and agricultural workers, but nothing has been developed to attract and move in new residents. Furthermore, even though officials are supposed to set aside 20% of projected dwellings for affordable housing, the local farmers say it would still be too expensive for them to stay.²⁸ Assuming prospective residents are found, SIIC has planned on a 50/50 lease to ownership ratio, which would ensure a diverse socioeconomic population. Perhaps Arup's and China's biggest fault in ensuring Dongtan is socially sustainable has been their failure to consult the local community about its development. While the plan has been well publicized internationally, most locals know very little about it. For example, when asked his opinion about the project, one farmer whose fields lie inside the site area said he had never even heard about it.²⁹

Conclusion

It is impossible to predict whether Masdar will succeed in becoming the world's first true eco-city. If, however, the successful development of an eco-city depends on a state's motivations and objectives for building it, the political and economic resources at its disposal and the overall sustainability of the city's design, then comparing the Dongtan and Masdar projects can provide insight into the UAE's chances for success. China's motivations for developing sustainable, environmentally friendly cities is more pressing, and narrowly focused than Abu Dhabi's, due to its overriding requirement to house a rapidly growing and urbanizing population. However, the UAE, based on its smaller government and population, buy-in from its most senior leaders, and vast oil and gas wealth, has both political and economic advantages over China in such an ambitious project. Furthermore, the UAE appears to have developed a more sustainable plan. Therefore, unless significant unexpected obstacles arise, Masdar City's chances for success are bright.

¹ Ecocitybuilders.org

² UN Brundtland Commission, *Our Common Future, Our Common Future*.

³ Jenicek et al., *Sustainability Indices for Military Installations*, 10.

⁴ *Climate Resilient Cities*, The World Bank and "Is Sustainable Attainable?" *Business and the Environment*.

⁵ Masdar City Website.

⁶ Heathcote, "The Greening of Arabia."

⁷ Kawach, "Car-free Masdar City will run on green PRTs."

⁸ World Bank, "China Environment."

⁹ World Bank, "Key Development Data & Statistics."

¹⁰ *International Energy Outlook 2009*, EIA.

¹¹ Energy Information Agency, "International Energy Statistics."

¹² CIA, *The World Factbook*.

¹³ International Monetary Fund, "World Economic Outlook Database" and *Energy in the UAE*, Embassy of the UAE.

¹⁴ Energy Information Agency, "UAE Energy Profile."

¹⁵ Energy Information Agency, "UAE Country Analysis Brief."

¹⁶ International Energy Agency, *CO₂ Emissions from Fuel Combustion*.

¹⁷ Larson, "China's Grand Plans."

¹⁸ Moore, "Dream Stuck..." and "In China, Overambition...", *Christian Science Monitor*.

¹⁹ "Is Sustainable Attainable?" *Business and the Environment*.

²⁰ Larson, "China's Grand Plans."

²¹ Head, *Urban Development to Combat Climate Change*.

²² “Arup and Dongtan, Worthy Winner of Greenwasher of the Year”

²³ “Zero-Carbon Cities.” *Architectural Record*.

²⁴ “In China, Overambition...”, Christian Science Monitor.

²⁵ Urban Agent, “Sustainable City Race.”

²⁶ Ibid

²⁷ Holson, “The Feng Shui Kingdom.”

²⁸ Urban Agent, “Sustainable City Race.”

²⁹ Moore, “Dream Stuck...”

Bibliography

- “Arup and Dongtan, Worthy Winner of Greenwasher of the Year.” *Ethical Corporation*.
<http://www.ethicalcorp.com/content.asp?ContentID=5552> (accessed 13 Dec 09).
- Beillo, David. “Eco-Cities of the Future.” *Scientific American Earth 3.0*, Vol. 18 Issue 4 (2008): 68-73.
- Central Intelligence Agency. “The World Factbook.”
<https://www.cia.gov/library/publications/the-world-factbook/index.html> (accessed 2 Dec 2009).
- “City of Dreams: A Chinese Eco-City.” *The Economist*, 21 March 2009.
- Climate Resilient Cities. City Profiles: Dongtan, China*. The World Bank. Washington, DC: 2009.
- Ecocity Builders*. <http://www.ecocityuilders.org> (accessed 9 Dec 2009).
- Energy in the UAE*. Embassy of the United Arab Emirates. www.ua-embassy.org. Washington, DC. October 2008.
- Energy Information Agency. “International Energy Statistics.”
<http://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm> (accessed 8 Dec 2009).
- Energy Information Agency. “UAE Country Analysis Brief.” Last updated: Nov 2009.
<http://www.eia.doe.gov/emeu/cabs/UAE/Full.html> (accessed 8 Dec 2009).
- Energy Information Agency. “UAE Energy Profile.” Last updated: 19 Nov 2009.
http://tonto.eia.doe.gov/country/country_energy_data.cfm?fips=TC (accessed 8 Dec 2009).
- Head, Peter R., and J. Gary Lawrence. *Urban Development to Combat Climate Change: Dongtan Eco-City and Risk Management Strategies*. Council on Tall Buildings and Urban Habitat (CTBUH) 8th World Congress Report, 2008.
- Heathcote, Edwin. “The Greening of Arabia.” *Financial Times*, 10 October 2009.
- Holson, Laura. “The Feng Shui Kingdom.” *The New York Times*, 25 April 2005.
- “In China, Overambition Reins in Eco-City Plans.” *Christian Science Monitor*, 24 December 2008, 25.
- International Energy Agency. *CO2 Emissions from Fuel Combustion, 2009 Edition*.
<http://www.iea.org/co2highlights/CO2highlights.pdf>.
- International Energy Outlook 2009*. DOE/EIA-0484(2009). Energy Information Administration. Washington, DC. 27 May 2009.

- International Monetary Fund. "World Economic Outlook Database, October 2009 Edition." <http://imf.org/external/pubs/ft/weo/2009/02/weodata/index.aspx> (accessed 10 Dec 2009).
- "Is Sustainable Attainable?" *Business and the Environment*, Vol. XVIII, No. 11 (November 2007): 10-11.
- Jenicek, Elisabeth M., Brian M. Deal and Adam Sagert. *Sustainability Indices for Military Installations*, ERDC/CERL TR-02-25. (Washington, DC: US Army Corps of Engineers, September 2002)
- Kawach, Nadim. "Car-free Masdar City will Run on Green PRTs." *Emirates Business* 24/7, 25 Jan 2009.
- Larson, Christina. "China's Grand Plans for Eco-Cities Now Lie Abandoned." *Yale Environment* 360, 6 April 2009. <http://e360.yale.edu/>.
- Masdar City website. <http://www.masdarcity.ae/en/index.aspx> (accessed 24 Nov 2009).
- Moore, Malcolm. "Dream Stuck on Drawing Board; Eco-City on the Rocks." *National Post (Canada)*, 20 October 2008.
- Shuster, Joseph M. *Beyond Fossil Fools*. Edina, MN: Beavers Pond Press, Inc., 2008.
- Smith, Zachary A., and Katrina D. Taylor. *Renewable and Alternative Energy Resources*. Santa Barbara, CA: ABC-CLIO, Inc., 2008.
- United Nations Brundtland Commission, *Our Common Future: The World Commission on Environment and Development*, 1987.
- Urban Agent. "Sustainable City Race, Parts 1-3." 9 April 2008. <http://agentsofurbanism.com/2008/04/sustainable-city-race-part-1-definition/>
- Energy Information Agency. "International Energy Statistics." <http://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm> (accessed 8 Dec 2009).
- Watts, Jonathan. "China Teams Up with Singapore to Build Huge Eco City." *The Guardian (London)*, 5 June 2009.
- World Bank. "China Environment." <http://go.worldbank.org/4OP4B09VE1> (accessed 7 Dec 2009).
- World Bank. "Key Development Data & Statistics." <http://go.worldbank.org/1SF48T40L0> (accessed 7 Dec 2009).
- "Zero-Carbon Cities." *Architectural Record*, Vol. 195 Issue 3 (March 2007): 54-54.